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(54) Title: A REDUCER AND AN INDUSTRIAL ROBOT

(57) Abstract: A reducer (100) comprises a casing (2), a low speed output part (3) coupled to the casing (2), a high speed input part (4), and a blocking film (6). The high speed input part (4) is coupled to the casing (2) and comprises an input shaft (41). An internal space (5) is enclosed by the casing (2). The low speed output part (3) and the high speed input part (4) are filled with a lubricant. The input shaft (41) comprises a channel (42) communicating the internal space (5) and an external environment. The blocking film (6) is arranged on the input shaft (41) to block the channel (42) and is permeable to air and non-permeable to the lubricant. In this way, the influence of the lubricant on the vent capability of the film could be reduced, such that the internal pressure could be released in time. An industrial robot comprising this reducer (100) is also provided.

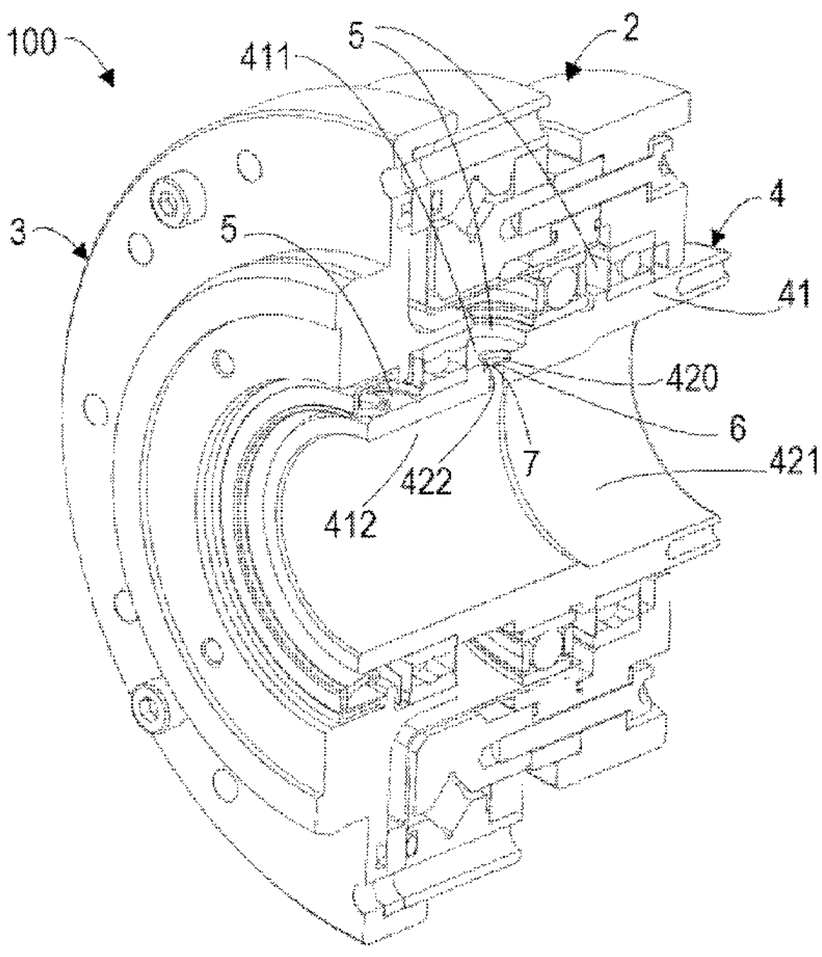

FIG. 1

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A REDUCER AND AN INDUSTRIAL ROBOT

FIELD

[0001] Embodiments of present disclosure generally relate to the field of reducers, and more particularly, to a reducer and an industrial robot.

BACKGROUND

[0002] A reducer is a machine for reducing a speed of drive power (torque) input to an input shaft and for transmitting the power to a target machine at a reduced speed. The reducer is widely used for driving various devices or machines, such as industrial robots, electric tools, and automobiles.

[0003] The reducer typically includes a casing, a high speed input part, and a low speed output part. The high speed input and low speed output parts are coupled to the casing and form an enclosed internal space together with the casing. A lubricant is provided in the internal space for friction reduction and for cooling purposes. During operation of the reducer, an internal pressure may be built up in the internal space due to various causes, such as an arising temperature, vaporization of the lubricant, and a pumping effect of sealing. The internal pressure buildup may cause the lubricant to leak out of the reducer. For example, in case that the reducer is used for driving a joint of an industrial robot, the leakage of the lubricant may degrade the lubricating performance of the reducer and contaminate the robot and work objects.

[0004] To prevent such an internal pressure buildup, for example, an air release hole may be provided on the reducer, and a film made of special material, such as Polytetrafluoroethylene (PTFE), is provided to block the air release hole. The film is permeable to air and non-permeable to the lubricant so as to release the internal pressure of the reducer and maintain the lubricant inside the internal space. However, if the lubricant reaches and sticks to the film, vent capability of the film may be adversely affected and thus the path to release the internal pressure would be blocked.

[0005] For a fixed-orientation application like automotive transmissions, it is possible

to place a vent value on the topmost side of the casing of the reducer, to minimize the influence of the lubricant on the film. However, for devices or machines which will change orientations during operation, such as the industrial robot application, it is difficult, sometimes impossible, to find such a fixed location for placing the vent value. For example, the reducer of a 6-axes robot rotates in any directions, and thus, the lubricant inside the reducer will definitely reach the film, leading to the reduction of the vent capability of the film.

[0006] US Patent No. US8171822B2 discloses a material with oil repellency, air permeability and non-permeability to oil. However, since the characteristics of lubricants may differ from one to another, a specific film material with oil repellency to various kinds of lubricants would be hard to be found as a common solution. Moreover, in US8171822B2, if the film is immerged by the lubricant at a certain orientation, the pressure release hole will be blocked.

[0007] Thus, there is a need for a solution for preventing lubricant leakage and internal pressure buildup of the reducer.

SUMMARY

[0008] In view of the foregoing problems, various example embodiments of the present disclosure provide a reducer that can prevent both lubricant leakage and internal pressure buildup.

[0009] In a first aspect of the present disclosure, example embodiments of the present disclosure provide a reducer. The reducer comprises a casing; a low speed output part coupled to the casing; a high speed input part coupled to the casing and comprising an input shaft, wherein an internal space enclosed by the casing, the low speed output part and the high speed input part is filed with a lubricant, and the input shaft comprises a channel communicating the internal space and an external environment; and a blocking film arranged on the input shaft to block the channel and being permeable to air and non-permeable to the lubricant.

[0010] In some embodiments, the input shaft is a hollow shaft, and wherein the

channel comprises: a central through hole extending from an end to the other end of the input shaft in an axial direction of the input shaft and being in fluid communication with the external environment; and a first through hole extending from an outer wall to an inner wall of the input shaft and communicating the internal space and the central through hole.

[0011] In some embodiments, the first through hole extends from the outer wall to the inner wall of the input shaft in a radial direction of the input shaft normal to the axial direction.

[0012] In some embodiments, the first through hole comprises a step portion on which the blocking film is arranged.

[0013] In some embodiments, the reducer further comprises a fixture configured to fix the blocking film onto the step portion of the first through hole.

[0014] In some embodiments, the input shaft is a solid shaft, and wherein the channel comprises: a lateral hole extending from an end of the input shaft to a position between two ends of the input shaft and being in fluid communication with the external environment; and a second through hole extending from an outer wall of the input shaft to the lateral hole and communicating the internal space and the lateral hole.

[0015] In some embodiments, the lateral hole extends in an axial direction of the input shaft.

[0016] In some embodiments, the second through hole extends from the outer wall of the input shaft to the lateral hole in a radial direction of the input shaft.

[0017] In some embodiments, the second through hole comprises a step portion on which the blocking film is arranged.

[0018] In some embodiments, the reducer further comprises a fixture configured to fix the blocking film onto the step portion of the second through hole.

[0019] In some embodiments, the reducer is used for driving a joint of an industrial robot.

[0020] In a second aspect of the present disclosure, example embodiments of the

present disclosure provide an industrial robot comprising a reducer according to the first aspect of the present disclosure.

[0021] According to various embodiments of the present disclosure, the channel and the film for blocking the channel are provided on the input shaft to release the internal pressure of the reducer and maintain the lubricant inside the internal space. With such an arrangement, the lubricant adhered to the film would fly away from the film during the operation of the reducer due to a centrifugal force generated by high speed rotation of the input shaft. In this way, the influence of the lubricant on the vent capability of the film could be reduced, such that the internal pressure could be released in time.

[0022] Moreover, since the position and orientation of the film changes over time, the film can be prevented from being immerged into the lubricant. Thus, the reducer is suitable for use in various devices or machines which change the position and orientation during operation, such as the industrial robots.

[0023] Further, the material of the film does not need to be oil repellency, because the lubricant adhered to the film is removed in a mechanical way, rather than in a chemical way. Thus, it is easy to find a suitable material for the film. Embodiments of the present disclosure provide a common solution to various kinds of lubricants with different chemical characteristics.

DESCRIPTION OF DRAWINGS

[0024] Through the following detailed descriptions with reference to the accompanying drawings, the above and other objectives, features and advantages of the example embodiments disclosed herein will become more comprehensible. In the drawings, several example embodiments disclosed herein will be illustrated in an example and in a non-limiting manner, wherein:

[0025] Fig. 1 illustrates a perspective view of a reducer in accordance with an embodiment of the present disclosure;

[0026] Fig. 2 illustrates a cross-sectional view of the reducer as shown in Fig. 1;

[0027] Fig. 3 illustrates a perspective view of a reducer in accordance with another

embodiment of the present disclosure; and

[0028] Fig. 4 illustrates a cross-sectional view of the reducer as shown in Fig. 3.

[0029] Throughout the drawings, the same or similar reference symbols are used to indicate the same or similar elements.

DETAILED DESCRIPTION OF EMBODIEMTNS

[0030] Principles of the present disclosure will now be described with reference to several example embodiments shown in the drawings. Though example embodiments of the present disclosure are illustrated in the drawings, it is to be understood that the embodiments are described only to facilitate those skilled in the art in better understanding and thereby achieving the present disclosure, rather than to limit the scope of the disclosure in any manner.

[0031] The term "comprises" or "includes" and its variants are to be read as open terms that mean "includes, but is not limited to." The term "or" is to be read as "and/or" unless the context clearly indicates otherwise. The term "based on" is to be read as "based at least in part on." The term "being operable to" is to mean a function, an action, a motion or a state can be achieved by an operation induced by a user or an external mechanism. The term "one embodiment" and "an embodiment" are to be read as "at least one embodiment." The term "another embodiment" is to be read as "at least one other embodiment." The terms "first," "second," and the like may refer to different or same objects. Other definitions, explicit and implicit, may be included below. A definition of a term is consistent throughout the description unless the context clearly indicates otherwise.

[0032] Unless specified or limited otherwise, the terms "mounted," "connected," "supported," and "coupled" and variations thereof are used broadly and encompass direct and indirect mountings, connections, supports, and couplings. Furthermore, "connected" and "coupled" are not restricted to physical or mechanical connections or couplings. In the description below, like reference numerals and labels are used to describe the same, similar or corresponding parts in the figures. Other definitions, explicit and implicit, may

be included below.

[0033] As discussed above, if the lubricant reaches and sticks to the film for releasing the internal pressure of the reducer, the vent capability of the film may be adversely affected and thus the path to release the internal pressure would be blocked. According to embodiments of the present disclosure, to prevent both lubricant leakage and internal pressure buildup, the channel and the film for blocking the channel are provided on the input shaft of the reducer to release the internal pressure of the reducer and avoid the sticking of the lubricant on the film. The above idea may be implemented in various manners, as will be described in detail in the following paragraphs.

[0034] Hereinafter, the principles of the present disclosure will be described in detail with reference to Figs. 1-4. Referring to Figs. 1 and 2 first, Fig. 1 illustrates a perspective view of a reducer 100 in accordance with an embodiment of the present disclosure, and Fig. 2 illustrates a cross-sectional view of the reducer 100 as shown in Fig. 1. As shown in Figs. 1 and 2, the reducer 100 generally includes a casing 2, a low speed output part 3, and a high speed input part 4. The high speed input part 4 and the low speed output part 3 are coupled to the casing 2 and form an enclosed internal space 5 together with the casing 2. A lubricant (not shown) is provided in the internal space 5 for friction reduction purposes. The high speed input part 4 includes an input shaft 41 for receiving a drive power (torque) input from a driver, such as a motor. The low speed output part 3 may transmit the power to a target machine at a reduced speed.

[0035] During operation of the reducer 100, an internal pressure may be built up in the internal space 5 due to various causes, such as an arising temperature, vaporization of the lubricant, and a pumping effect of sealing. To release the internal pressure in the internal space 5 of the reducer 100, a channel 42 is provided in the input shaft 41. The channel 42 communicates the internal space 5 and an external environment. The reducer 100 further includes a blocking film 6 arranged on the input shaft 41 to block the channel 42. The blocking film 6 is permeable to air and non-permeable to the lubricant so as to release the internal pressure of the reducer 100 and maintain the lubricant inside the internal space 5.

[0036] Since the channel 42 and the blocking film 6 for blocking the channel 42 are provided on the input shaft 41, the blocking film 6 may rotate in synchronization with the

input shaft 41 when the input shaft 41 rotates. The rotation of the blocking film 6 would cause the lubricant (if any) adhered on the blocking film 6 to be subjected to a centrifugal force. Under the centrifugal force, the lubricant adhered on the blocking film 6 would fly away from the blocking film 6 during the high speed rotation of the input shaft 41. In this way, the influence of the lubricant on the vent capability of the blocking film 6 could be reduced, such that the internal pressure of the reducer 100 could be released in time.

[0037] In some embodiments, as shown in Figs. 1 and 2, the input shaft 41 is a hollow shaft. The hollow input shaft 41 includes a central through hole 421 extending from an end to the other end of the input shaft 41 in an axial direction X of the input shaft 41. The central through hole 421 is in fluid communication with the external environment.

[0038] In an embodiment, the input shaft 41 further includes a first through hole 422 extending from an outer wall 411 to an inner wall 412 of the input shaft 41. The first through hole 422 communicates the internal space 5 and the central through hole 421. With such an arrangement, the first through hole 422 together with the central through hole 421 may form the channel 42, such that the internal space 5 is in fluid communication with the external environment. The blocking film 6 may be arranged on the input shaft 41 to cover the first through hole 422.

[0039] In another embodiment, in addition to the first through hole 422, the input shaft 41 may further include one or more additional through holes communicating the internal space 5 and the central through hole 421. Likewise, the additional through holes are covered by corresponding blocking films. The provision of the additional through holes on the input shaft 41 may further improve the release performance of the internal pressure in the reducer 100.

[0040] In some embodiments, as shown in Figs. 1 and 2, the first through hole 422 extends from the outer wall 411 to the inner wall 412 of the input shaft 41 in a radial direction R of the input shaft 41 normal to the axial direction X. In some embodiments, the first through hole 422 may extend from the outer wall 411 to the inner wall 412 of the input shaft 41 in a direction oblique with respect to the radial direction R of the input shaft 41. In other embodiments, the first through hole 422 may be curved or even include a plurality of sub-portions in communication with each other, as long as these sub-

portions communicate the internal space 5 and the central through hole 421.

[0041] In some embodiments, as shown in Figs. 1 and 2, the first through hole 422 includes a step portion 420. The blocking film 6 is arranged on the step portion 420. In an embodiment, the reducer 100 may further include a fixture 7 adapted to fix the blocking film 6 onto the step portion 420 of the first through hole 422. For example, the fixture 7 may be formed as a ring fixture. The ring fixture 7 may be interference fit with the first through hole 422. Through pressing the ring fixture 7 into the first through hole 422, the blocking film 6 may be fixed onto the step portion 420 reliably.

[0042] In some embodiments, the blocking film 6 may be adhered onto the input shaft 41 through adhesives so as to cover the first through hole 422. In other embodiments, the blocking film 6 may be fixed onto the input shaft 41 in other ways. The scope of the present disclosure is not intended to be limited in this respect.

[0043] Fig. 3 illustrates a perspective view of a reducer 100 in accordance with another embodiment of the present disclosure, and Fig. 4 illustrates a cross-sectional view of the reducer 100 as shown in Fig. 3. Similar to the reducer 100 as shown in Figs 1 and 2, the reducer 100 as shown in Figs. 3 and 4 also includes a casing 2, a low speed output part 3, and a high speed input part 4. The high speed input part 4 and the low speed output part 3 are coupled to the casing 2 and form an enclosed internal space 5 together with the casing 2. The lubricant is provided in the internal space 5 for friction reduction purposes.

[0044] During operation of the reducer 100, an internal pressure may be built up in the internal space 5 due to various causes. To release the internal pressure in the internal space 5 of the reducer 100, a channel 42 is provided in the input shaft 41. The channel 42 communicates the internal space 5 and an external environment. The reducer 100 further includes a blocking film 6 arranged on the input shaft 41 to block the channel 42. The blocking film 6 is permeable to air and non-permeable to the lubricant so as to release the internal pressure of the reducer 100 and maintain the lubricant inside the internal space 5.

[0045] In some embodiments, as shown in Figs. 3 and 4, the input shaft 41 is a solid shaft. The solid input shaft 41 includes a lateral hole 423 extending from an end of the input shaft 41 to a position between two ends of the input shaft 41. The lateral hole 423

is in fluid communication with the external environment. The solid input shaft 41 further includes a second through hole 424 extending from an outer wall 411 of the input shaft 41 to the lateral hole 423. The second through hole 424 communicates the internal space 5 and the lateral hole 423. With such an arrangement, the second through hole 424 together with the lateral hole 423 may form the channel 42, such that the internal space 5 is in fluid communication with the external environment. The blocking film 6 may be arranged on the input shaft 41 to cover the second through hole 424.

[0046] In some embodiments, as shown in Figs. 3 and 4, the lateral hole 423 extends in an axial direction X of the input shaft 41. In some embodiments, the lateral hole 423 may extend in a direction oblique with respect to the axial direction X of the input shaft 41. In other embodiments, the lateral hole 423 may be curved or even include a plurality of sub-portions in communication with each other, as long as these sub-portions communicate the second through hole 424 and the external environment.

[0047] In some embodiments, as shown in Figs. 3 and 4, the second through hole 424 extends from the outer wall 411 of the input shaft 41 to the lateral hole 423 in a radial direction R of the input shaft 41. In some embodiments, the second through hole 424 may extend from the outer wall 411 of the input shaft 41 to the lateral hole 423 in a direction oblique with respect to the radial direction R of the input shaft 41. In other embodiments, the second through hole 424 may be curved or even include a plurality of sub-portions in communication with each other, as long as these sub-portions communicate the internal space 5 and the lateral hole 423.

[0048] Similar to the first through hole 422, as shown in Figs. 3 and 4, the second through hole 424 may include a step portion 420. The blocking film 6 is arranged on the step portion 420. In an embodiment, the reducer 100 may further include a fixture 7 adapted to fix the blocking film 6 onto the step portion 420 of the second through hole 424. For example, the fixture 7 may be formed as a ring fixture. The ring fixture 7 may be interference fit with the second through hole 424. Through pressing the ring fixture 7 into the second through hole 424, the blocking film 6 may be fixed onto the step portion 420 reliably.

[0049] In some embodiments, the blocking film 6 may be adhered onto the input shaft

41 through adhesives so as to cover the second through hole 424. In other embodiments, the blocking film 6 may be fixed onto the input shaft 41 in other ways. The scope of the present disclosure is not intended to be limited in this respect.

[0050] The reducer 100 may be of various types, such as a harmonic reducer, a gear reducer, and the like. Moreover, the reducer 100 may be used in various devices or machines, such as industrial robots, electric tools, and automobiles. For example, the reducer 100 may be used for driving a joint of an industrial robot.

[0051] According to various embodiments of the present disclosure, the channel 42 and the blocking film 6 are provided on the input shaft 41 to release the internal pressure of the reducer 100 and maintain the lubricant inside the internal space 5. With such an arrangement, the lubricant adhered to the blocking film 6 would fly away from the blocking film 6 during the operation of the reducer 100 due to a centrifugal force generated by high speed rotation of the input shaft 41. In this way, the influence of the lubricant on the vent capability of the blocking film 6 could be reduced, such that the internal pressure could be released in time.

[0052] Moreover, since the position and orientation of the blocking film 6 changes over time, the blocking film 6 can be prevented from being immerged into the lubricant. Thus, the reducer 100 is suitable for use in various devices or machines which change the position and orientation during operation, such as the industrial robots.

[0053] Further, the material of the blocking film 6 does not need to be oil repellency, because the lubricant adhered to the blocking film 6 is removed in a mechanical way, rather than in a chemical way. Thus, it is easy to find a suitable material for the blocking film 6. In embodiments of the present disclosure, the blocking film 6 may be of various known materials, such as Polytetrafluoroethylene (PTFE), or other available materials to be developed in the future. In fact, embodiments of the present disclosure provide a common solution to various kinds of lubricants with different chemical characteristics.

[0054] While several inventive embodiments have been described and illustrated herein, those of ordinary skill in the art will readily envision a variety of other means and/or structures for performing the function and/or obtaining the results and/or one or more of the advantages described herein, and each of such variations and/or

modifications is deemed to be within the scope of the inventive embodiments described herein. More generally, those skilled in the art will readily appreciate that all parameters, dimensions, materials, and configurations described herein are meant to be exemplary and that the actual parameters, dimensions, materials, and/or configurations will depend upon the specific application or applications for which the inventive teachings is/are used. Those skilled in the art will recognize, or be able to ascertain using no more than routine experimentation, many equivalents to the specific inventive embodiments described herein. It is, therefore, to be understood that the foregoing embodiments are presented by way of example only and that, within the scope of the appended claims and equivalents thereto, inventive embodiments may be practiced otherwise than as specifically described and claimed. Inventive embodiments of the present disclosure are directed to each individual feature, system, article, material, kit, and/or method described herein. In addition, any combination of two or more such features, systems, articles, materials, kits, and/or methods, if such features, systems, articles, materials, kits, and/or methods are not mutually inconsistent, is included within the inventive scope of the present disclosure.

WHAT IS CLAIMED IS:

1. A reducer (100) comprising:

a casing (2);

a low speed output part (3) coupled to the casing (2);

a high speed input part (4) coupled to the casing (2) and comprising an input shaft (41), wherein an internal space (5) enclosed by the casing (2), the low speed output part (3) and the high speed input part (4) is filed with a lubricant, and the input shaft (41) comprises a channel (42) communicating the internal space (5) and an external environment; and

a blocking film (6) arranged on the input shaft (41) to block the channel (42) and being permeable to air and non-permeable to the lubricant.

2. The reducer (100) according to claim 1, wherein the input shaft (41) is a hollow shaft, and wherein the channel (42) comprises:

a central through hole (421) extending from an end to the other end of the input shaft (41) in an axial direction (X) of the input shaft (41) and being in fluid communication with the external environment; and

a first through hole (422) extending from an outer wall (411) to an inner wall (412) of the input shaft (41) and communicating the internal space (5) and the central through hole (421).

3. The reducer (100) according to claim 2, wherein the first through hole (422) extends from the outer wall (411) to the inner wall (412) of the input shaft (41) in a radial direction (R) of the input shaft (41) normal to the axial direction (X).

4. The reducer (100) according to claim 3, wherein the first through hole (422) comprises a step portion (420) on which the blocking film (6) is arranged.

5. The reducer (100) according to claim 4, further comprising a fixture (7) configured to fix the blocking film (6) onto the step portion (420) of the first through hole

(422).

6. The reducer (100) according to claim 1, wherein the input shaft (41) is a solid shaft, and wherein the channel (42) comprises:

a lateral hole (423) extending from an end of the input shaft (41) to a position between two ends of the input shaft (41) and being in fluid communication with the external environment; and

a second through hole (424) extending from an outer wall (411) of the input shaft (41) to the lateral hole (423) and communicating the internal space (5) and the lateral hole (423).

7. The reducer (100) according to claim 6, wherein the lateral hole (423) extends in an axial direction (X) of the input shaft (41).

8. The reducer (100) according to claim 6, wherein the second through hole (424) extends from the outer wall (411) of the input shaft (41) to the lateral hole (423) in a radial direction (R) of the input shaft (41).

9. The reducer (100) according to claim 8, wherein the second through hole (424) comprises a step portion (420) on which the blocking film (6) is arranged.

10. The reducer (100) according to claim 9, further comprising a fixture (7) configured to fix the blocking film (6) onto the step portion (420) of the second through hole (424).

11. The reducer (100) according to claim 1, wherein the reducer (100) is used for driving a joint of an industrial robot.

12. An industrial robot comprising a reducer (100) according to any of claims 1-11.

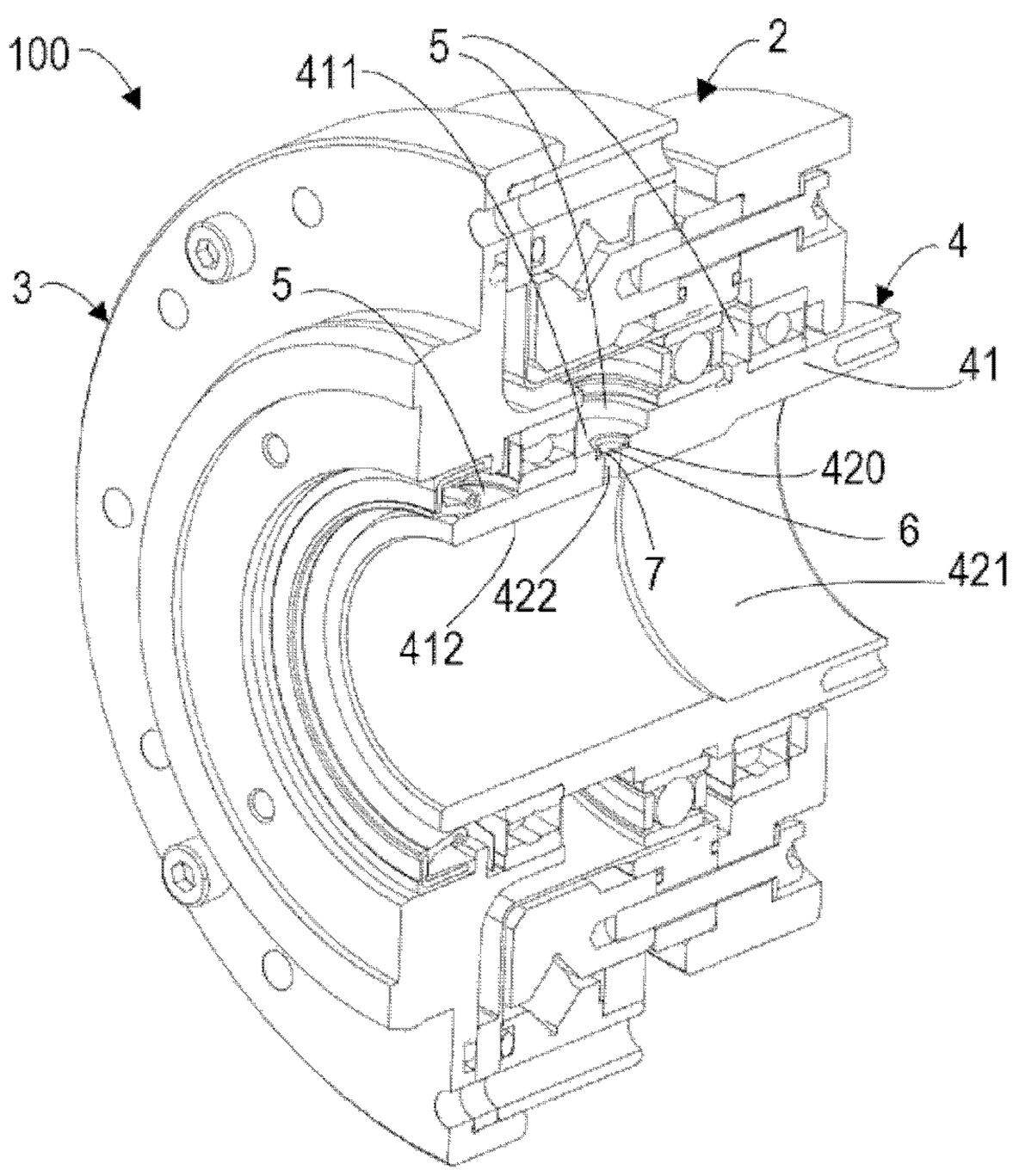

FIG. 1

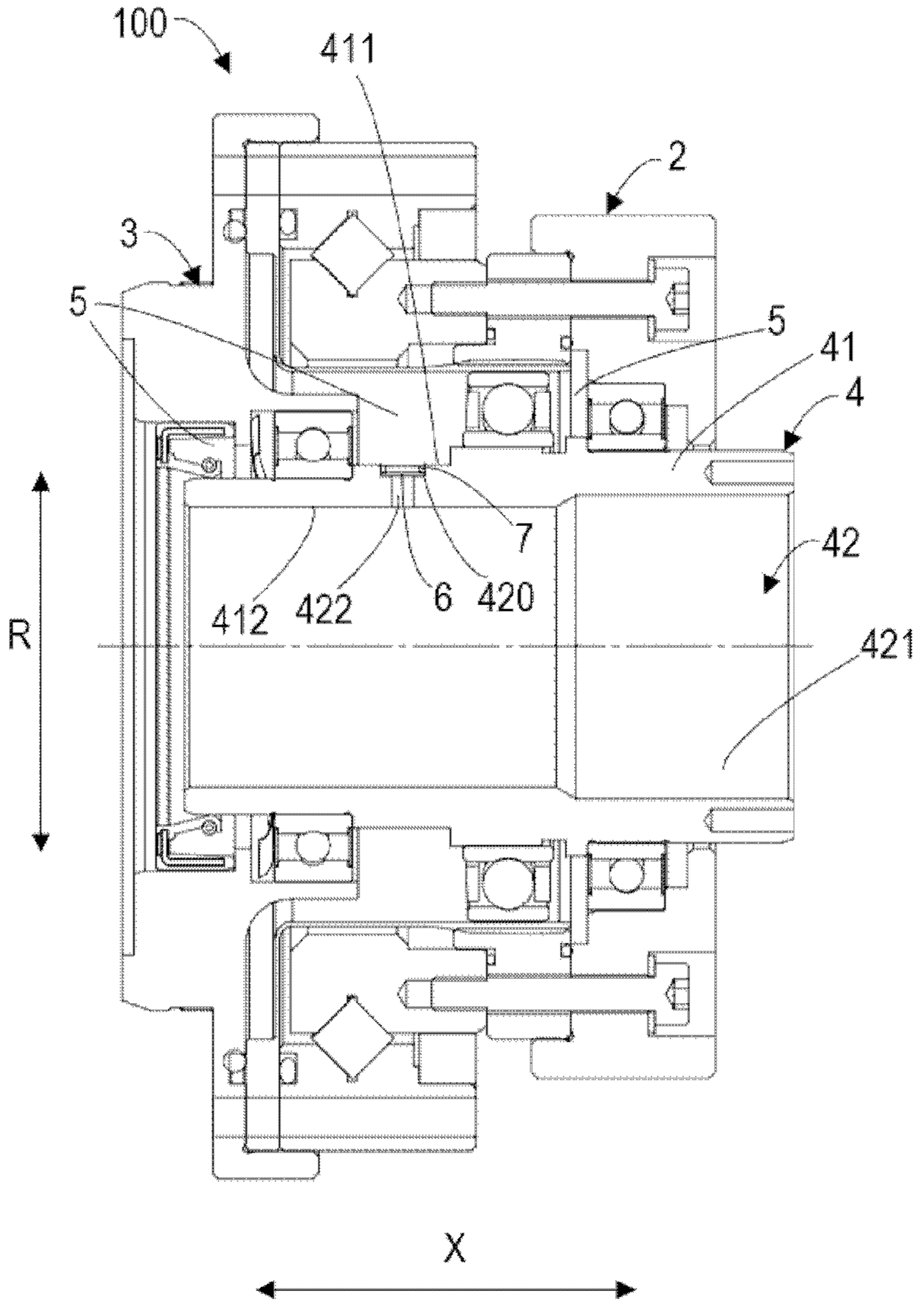

FIG. 2

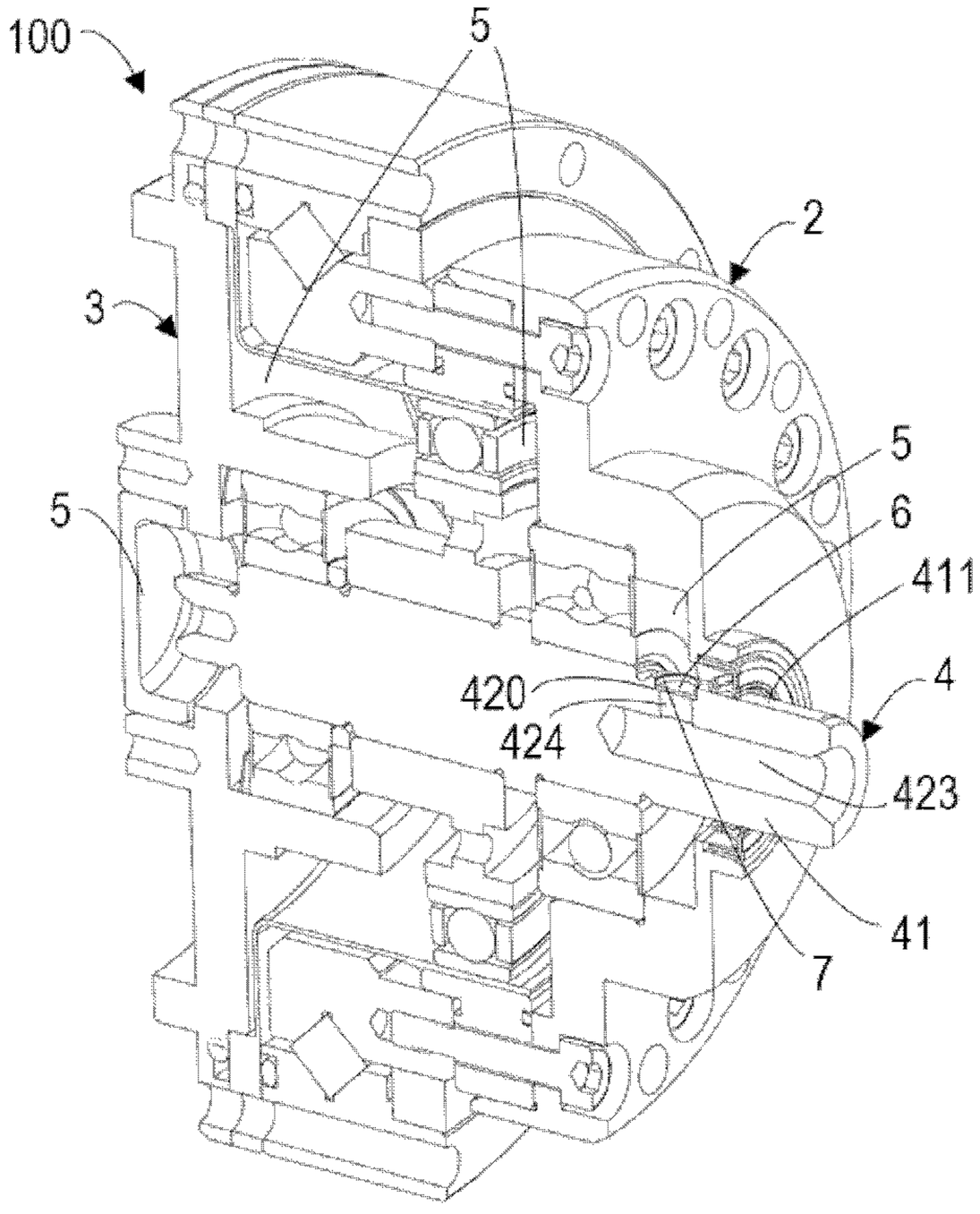

FIG. 3

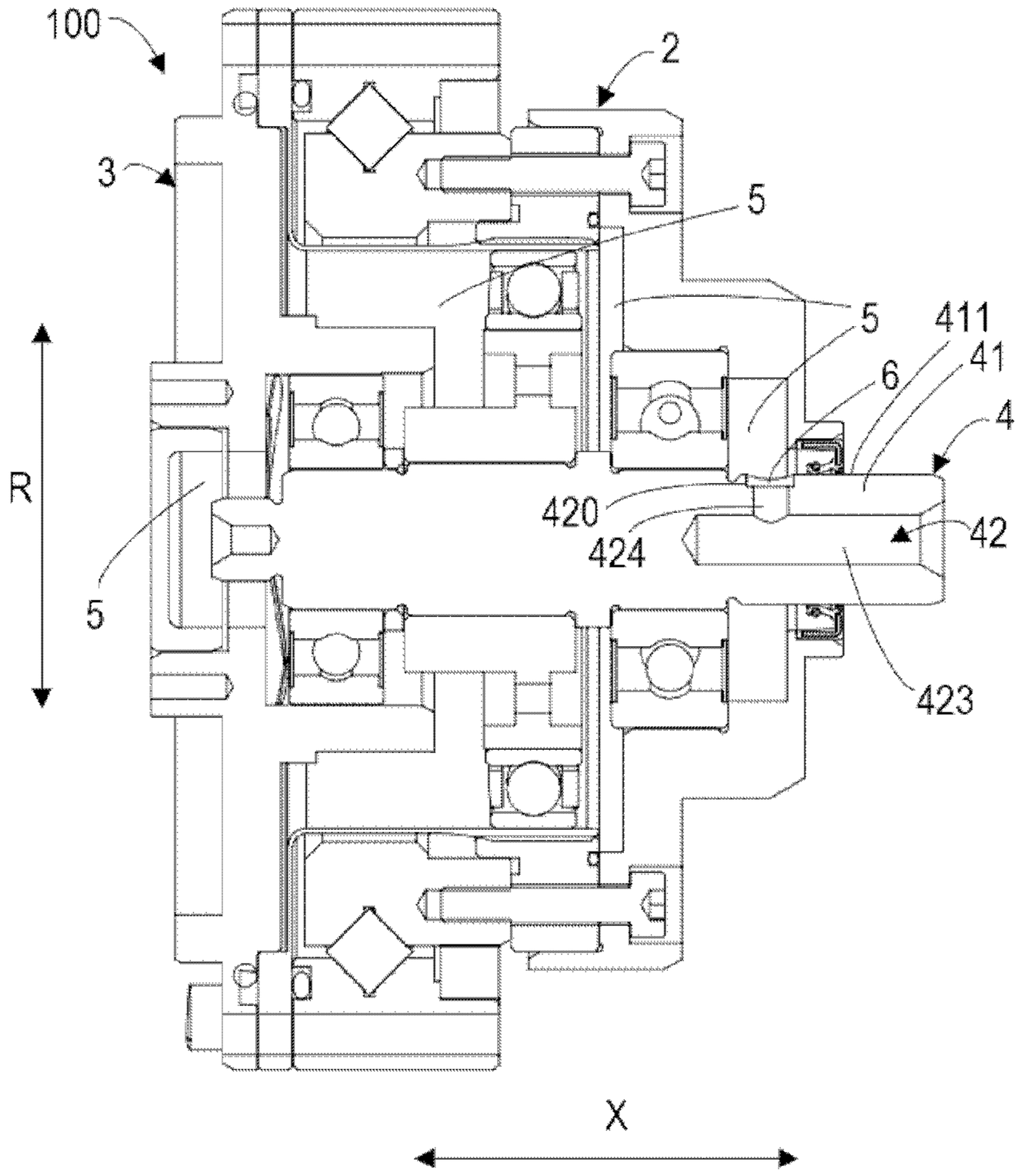

FIG. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2019/114583

A. CLASSIFICATION OF SUBJECT MATTER

F16H 57/04(2010.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F16H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNABS, DWPI, CNPAT reducer, casing, input, output, lubricant, channel, passage, film

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 108569618 A (TIANJIN FUMA REDUCER CO LTD) 25 September 2018 (2018-09-25) description pages 3-5, figure 1	1-12
A	CN 105626839 A (QIJIANG YONGYUE GEAR CO LTD) 01 June 2016 (2016-06-01) the whole document	1-12
A	CN 107763142 A (HU CHANG QUAN et al) 06 March 2018 (2018-03-06) the whole document	1-12
A	CN 104265838 A (TIANJIN HUAYE RONGCHENG PRECISION MACHIN) 07 January 2015 (2015-01-07) the whole document	1-12
A	US 2014154054 A1 (UNITED TECHNOLOGIES CORP) 05 June 2014 (2014-06-05) the whole document	1-12
A	KR 20130043450 A (HYUNDAI DYMOS INC) 30 April 2013 (2013-04-30) the whole document	1-12

☐ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
09 December 2019	**19 February 2020**
Name and mailing address of the ISA/CN **National Intellectual Property Administration, PRC** **6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing** **100088** **China** Facsimile No. **(86-10)62019451**	Authorized officer **SONG,Yiqun** Telephone No. **86-10-62085415**

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2019/114583

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
CN 108569618 A	25 September 2018	None	
CN 105626839 A	01 June 2016	None	
CN 107763142 A	06 March 2018	None	
CN 104265838 A	07 January 2015	None	
US 2014154054 A1	05 June 2014	US 9194255 B2	24 November 2015
KR 20130043450 A	30 April 2013	None	